PHYTOTOXICOLOGY 1997 INVESTIGATION:

HEATHER AND LITTLE LIMITED

TORONTO

SEPTEMBER 1998

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Report prepared by:

William I. Gizyn
Standards Development Branch
Phytotoxicology Section
Ontario Ministry of the Environment

Report No: SDB-008-3511-1998

Background:

In 1994, a resident of Ivy Avenue, in the eastern part of the City of Toronto, requested an investigation by the Phytotoxicology Section. This resident's property shared a property line with a storage yard used by a roofing company, Heather and Little Limited. This company used the yard to store roofing materials and equipment. The focus of the investigation was whether materials, or their chemical constituents, stored in the yard, had migrated onto the resident's property.

The investigation identified excessive concentrations of polycyclic aromatic hydrocarbons (PAHs) in the surface soil in the rear yard of this residential property. However, the evidence disclosed by this investigation was insufficient to attribute the contamination to operations at the storage yard. Because roofing materials could contain PAHs, the Heather and Little storage yard remained a probable source of the PAH contamination.

In 1995, a more extensive investigation was conducted to determine if PAHs contained in materials stored at the yard had contaminated the soil of other residential properties. Eight other residential properties on the north side of Ivy Avenue had soil samples collected from their rear yards. Four of these properties had rear yards bordering directly onto the storage yard and four properties did not. The chemical analysis of the soil revealed PAH concentrations covering a wide range, with most samples containing PAHs that exceeded MOE health-based guidelines. Soil from two of the properties contained PAHs whose concentrations were extremely high.

This investigation demonstrated PAH contamination that was not confined to those properties bordering the Heather and Little storage yard, but extending to properties at the east end of Ivy Avenue, tens of metres from the storage yard. The results of this investigation were compiled in a report, *Phytotoxicology Survey Report: PAH Contamination on Ivy Avenue, Toronto (1995), Report No. SDB -067-3511-1996.*

Because PAH contaminated soil has the potential of posing a health risk, the City of Toronto Public Health Department and residents of the neighbourhood were notified about the contamination. The first public meeting was held in February 1997.

1997 Investigation:

While the 1995 investigation revealed excessive PAH contamination of soil on properties that were at some distance from the storage yard, the still limited sampling remained inadequate to delineate the extent of this contamination. Consequently, a more intensive and systematic sampling program was required.

Such a program was designed while considering any information regarding use or possible use of PAH-containing materials in the neighbourhood. Also considered were construction and other activities in the neighbourhood that might shed some light on the distribution of PAH contamination. As new information became available, the sampling plan was expanded to address it. Ultimately, there were three sampling periods. The initial one was in April 1997, with supplemental sampling in July and August 1997.

The underlying premise to the sampling plan was that Heather and Little activities were the primary source of the PAH contamination. This was based on the fact that this company, as well as others in this type of business, historically used coal tar pitch in flat roof construction. This material has a very high PAH content.

The sampling plan involved stratification of the neighbourhood into "Blocks" of properties. Samples would be collected from a number of properties or locations within each Block. This approach was required to ensure that sampling locations were distributed throughout the target area and that the number of samples did not exceed the analytical capacity of the laboratory. The locations of the Blocks are shown in the figure on the following page. Descriptions of sampling locations falling within each Block follow.

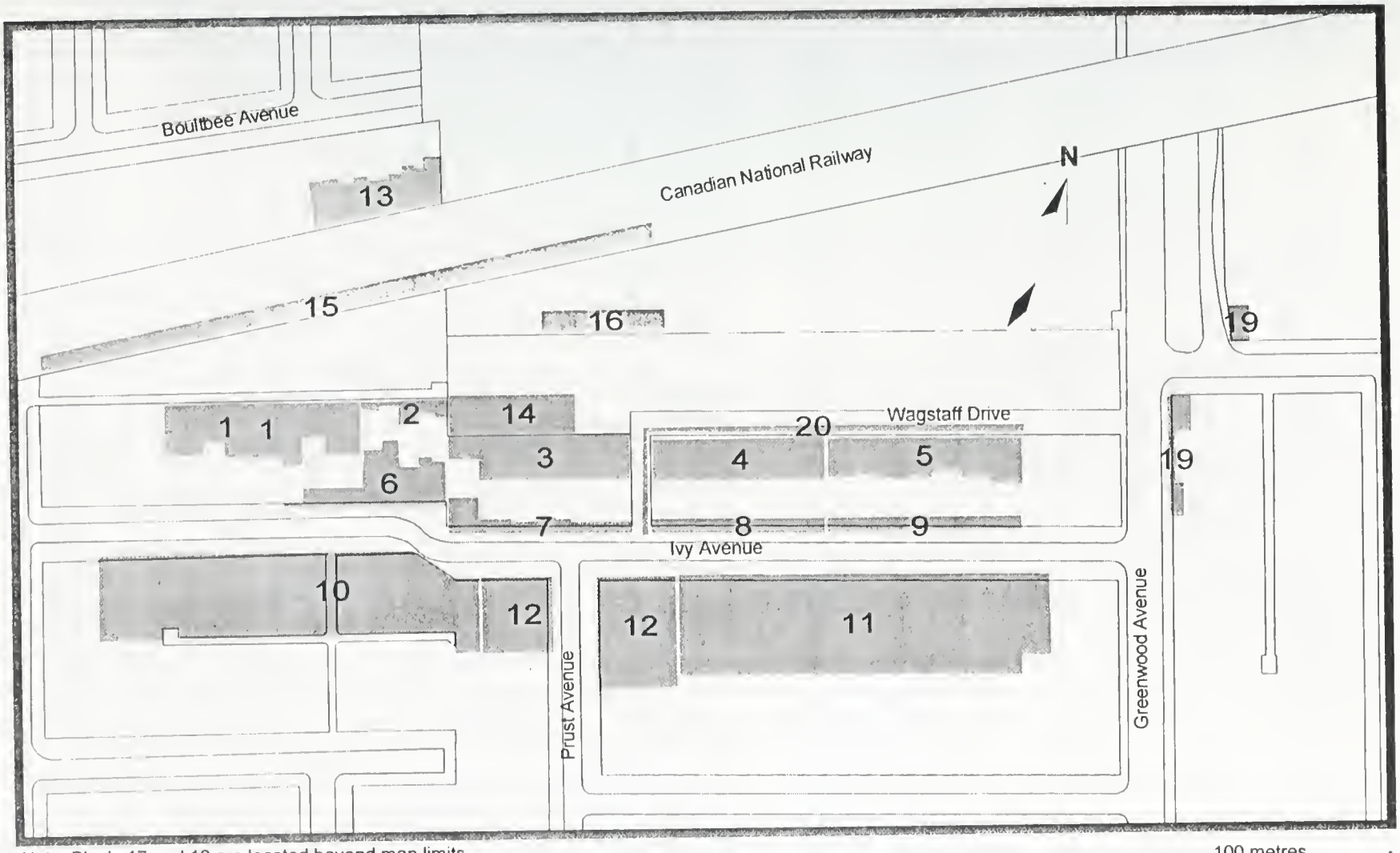
Block 1 - residential rear yards from 14 to 36 Ivy Avenue
Block 2 - residential rear yards from 38 to 48 Ivy Avenue
Block 3 - residential rear yards from 50 to 78 Ivy Avenue
Block 4 residential rear yards from 80 to 106 Ivy Avenue
Block 5 - residential rear yards from 112 to 138 Ivy Avenue
Block 6 - residential front yards from 26 to 48 Ivy Avenue
Block 7 - residential front yards from 50 to 78 Ivy Avenue
Block 8 - residential front yards from 80 to 106 Ivy Avenue
Block 9 - residential front yards from 112 to 138 Ivy Avenue
Block 10 - residential front or rear yards from 1 to 89 Ivy Avenue
Block 11 - residential front or rear yards from 91 to 141 Ivy Avenue
Block 12 - residential front or rear yards at north end of Prust
Block 13 - residential rear yards at east end of Boultbee Avenue
Block 14 - Heather and Little storage yard
Block 15 - railway right-of-way
Block 16 - embankment north of Heather and Little storage yard
Block 17 - Leslieville Public School and Greenwood Park
Block 18 - roadside locations along Dorothy Street
Block 19 - residential front yards on east side of Greenwood Avenue
Block 20 - beneath concrete pavement on Wagstaff Drive

Prior to collecting a sample, all equipment that would be in contact with the sample was washed in a detergent solution, rinsed with deionized water, and then successively rinsed with acetone and hexane. The amber glass jars that would hold the samples had been previously cleaned by the analytical laboratory.

Most of the sampling was conducted with an Oakfield™ soil corer. This device removes a two-centimetre cylindrical core when inserted into the soil. The soil depth from which the sample was collected is controlled by the depth to which the corer is inserted. In this investigation, samples from residential properties consisted of the top five centimetres of soil. At some residential property sampling locations, samples were also collected from the 40 to 60 centimetre depth. This was accomplished by inserting the corer to its full length, which was 40 centimetres, withdrawing the soil core, and discarding the soil. The corer was then inserted back into the hole and forced down an additional 20 centimetres.

A sample consisted of a number of soil cores, about 25 where the top five centimetres was being sampled, and about 10 for the 40 to 60 centimetre samples. The cores were collected from randomly distributed points, placed into a stainless-steel bowl, homogenized with stainless-steel spoon and transferred to the amber glass jar. The samples were submitted to the MOE

Figure: Configuration of Sampling Location Blocks in the Vicinity of Heather and Little Limited, Toronto



Note: Blocks17 and 18 are located beyond map limits.

Laboratory Services Branch for PAH analysis. The laboratory reports concentrations for 16 PAH compounds.

In two parts of the neighbourhood, the soil coring technique for obtaining samples could not be employed. These were the H&L yard and Wagstaff Drive. Limestone aggregate mixed into the soil at the H&L yard prevented the soil corer from penetrating to any depth.

Samples from the H&L yard were collected by scraping the top centimetre of surface material and agitating it in a sampling bowl to bring the course material to the surface. The samples consisted of the finer material that settled to the bottom of the bowl.

The 60 to 70 centimetre sample was collected with a hand auger. A hole was augered to 60 centimetres and cleared of loose material. The augering was continued for an additional 10 centimetres, and the material adhering to the auger was brought to the surface as the sample. Coarse material was removed in the same manner as for the surface samples.

The surface of Wagstaff Drive was paved with concrete in 1980. To permit sampling of the old dirt roadbed would require drilling through the concrete pavement. Arrangements for this were made by the City of Toronto, Department of Public Works. A truck-mounted auger opened 10 sampling ports through the concrete along the length of the roadway.

Samples were obtained by scooping out the top two centimetres of soil beneath the concrete pavement around the openings. These soil samples was placed directly into sample jars.

Results:

The complete results of the chemical analyses are not being reported in this document. These data can be made available to all parties that have an interest. Complete results for particular residential properties have already been provided to the respective property owners. Instead, a table containing information about the sample and the sampling location has been prepared and supplemented with columns labelled 'Total PAH' and 'B(a)P'. The first contains the sum of the 16 individual PAH compound concentrations reported by the laboratory. The summation did not include any special treatment for data qualified as being near or below limits of detection or quantification. The second column contains the benzo(a)pyrene (B(a)P) concentrations for the samples. B(a)P is classified as a probable human carcinogen by the USEPA. The MOE health-based B(a)P criteria for soil remmediation are the lowest of the PAHs. They are 1,200 nanograms per gram (ng/g) for residential or parkland use, and 1,900 ng/g for industrial or commercial land use. Appendix 1 contains a discussion of the derivation and significance of these criteria.

The results table has been organized sequentially by Block number. Other columns contain the sampling dates, sample numbers, location codes (which identify the sampling locations in an internal Phytotoxicology database), and sampling depths. It should be noted that, for residential property sampling locations, the house numbers have been excluded. This is to ensure confidentiality about conditions on these private properties. Residential property sampling locations have been assigned arbitrary numbers (in parentheses in 'Location No.' column) to facilitate their identification in the Discussion section of this document.

This table also includes data for samples collected in 1995. Italics have been used to highlight these records. In 1995, residential yards in Block 3 had more than one area sampled. These instances are identified with Rear 1, Rear 2 and Rear 3 in the 'Yard' column.

Heather & Little Limited - *1995* and 1997 - Sampling Locations and PAH Concentrations (ng/g)

Date	No.	Loc. Code	Block	Location No.	Yard res	Depth	Total PAH	B(a)P
1997/04/21	101	3257018	1	Ivy Ave. (1)	Rear	0 - 5	3,540	200
1997/04/21	102	3257019	1	Ivy Ave. (2)	Rear	0 - 5	8,300	**480**
1997/04/21	103	3257019	1	Ivy Ave. (2)	Rear	40 - 60	5,740	280
1997/04/21	104	3257020	1	Ivy Ave. (3)	Rear	0 - 5	1,420	80 T
1997/04/22	105	3257021	2	Ivy Ave. (4)	Rear	0 - 5	4,200	240
1997/04/22	106	3257021	2	Ivy Ave. (4)	Rear	40 - 60	880	40 W
1997/04/22	107	3257022	2	Ivy Ave. (5)	Rear	0 - 5	66,500	**3,800**
1997/04/22	108	3257023	3	Ivy Ave. (6)	Rear	0 - 5	4,960	**320**
1995/10/11	*4417*	*3257001*	*3*	*Ivy Ave.* (7)	*Rear 1*	*0 - 5*	*5,480*	***440***
1995/10/11	*4418*	*3257002*	*3*	*Ivy Ave.* (7)	*Rear 2*	*0 - 5*	*11,980*	***960***
1995/10/11	*4419*	*3257003*	*3*	*Ivy Ave.* (7)	*Rear 3*	*0 - 5*	*7,100*	***560***
1997/04/22	109	3257024	3	Ivy Ave. (7)	Rear	40 - 60	8,680	**680**
1995/10/11	*4420*	*3257004*	*3*	*Ivy Ave.* (8)	*Rear 1*	*0 - 5*	*53,060*	***4,200***
1995/10/11	*4421*	*3257005*	*3*	*Ivy Ave.* (8)	*Rear 2*	*0 - 5*	*53,000*	***4,300***
1995/10/11	*4422*	*3257006*	*3*	*Ivy Ave.* (8)	*Rear 3*	*0 - 5*	*10,160*	***760***
1995/10/11	*4423*	*3257007*	*3*	*Ivy Ave.* (9)	*Rear 1*	*0 - 5*	*728,460*	***36,000***
1995/10/11	*4424*	*3257008*	*3*	*Ivy Ave.* (9)	*Rear 2*	*0 - 5*	*521,720*	***24,000***
1995/10/11	*4425*	*3257009*	*3*	*Ivy Ave.* (9)	*Rear 3*	*0 - 5*	*595,160*	***21,000***
1997/04/22	110	3257025	3	Ivy Ave. (9)	Rear	40 - 60	33,360	**2,000**
1997/04/22	111	3257026	3	Ivy Ave. (10)	Rear	0 - 5	16,880	**960**
1995/10/11	*4426*	*3257010*	*3*	*Ivy Ave.* (11)	*Rear 1*	*0 - 5*	*21,020*	***1,600***
1995/10/11	*4427*	*3257011*	*3*	*Ivy Ave.* (11)	*Rear 2*	*0 - 5*	*32,360*	***2,800***
1995/10/11	*4428*	*3257012*	*3*	*Ivy Ave.* (12)	*Rear 1*	*0 - 5*	*14,940*	***1,100***
1995/10/11	*4429*	*3257013*	*3*	*Ivy Ave.* (12)	*Rear 2*	*0 - 5*	*35,660*	***2,800***
1995/10/11	*4430*	*3257014*	*3*	*Ivy Ave.* (12)	*Rear 3*	*0 - 5*	39,240	**3,500**
1997/04/22	112	3257027	3	Ivy Ave. (12)	Rear	40 - 60	16,280	**920**
1997/04/22	113	3257028	3	Ivy Ave. (13)	Rear	0 - 5	155,380	**12,000**
1997/04/22	114	3257029	3	Ivy Ave. (14)	Rear	0 - 5	229,260	**12,000**
1997/04/22	115	3257030	4	Ivy Ave. (15)	Rear	0 - 5	22,500	**1,400**
1997/07/24	2207	3257078	4	Ivy Ave. (16)	Rear	0 - 5	38,200	**2,600**
1997/04/25	167	3257071	4	Ivy Ave. (17)	Rear	0 - 5	100,160	**7,400**
1995/10/11	*4431*	*3257015*	*4*	*Ivy Ave.* (18)	*Rear*	*0 - 5*	*1,149,600*	***37,000***
1997/04/22	116	3257015	4	Ivy Ave. (18)	Rear	40 - 60	3,920	200
1997/04/22	117	3257031	4	Ivy Ave. (19)	Rear	0 - 5	118,960	**5,800**
1995/10/11	*4432*	*3257016*	*4*	*Ivy Ave.* (20)	*Rear*	*0 - 5*	*31,500*	***2,700***
1997/04/22	118	3257016	4	Ivy Ave. (20)	Rear	40 - 60	1,180	40 W
1997/04/22	119	3257032	4	Ivy Ave. (21)	Rear	0 - 5	41,800	**2,200**
1995/10/11	*4433*	*3257017*	*5*	*Ivy Ave.* (22)	*Rear*	*0 - 5*	*26,280*	***2,000***
1997/04/22	120	3257033	5	Ivy Ave (23)	Rear	0 - 5	23,840	**1,300**
1997/04/22	121	3257034	5	Ivy Ave. (23)	Rear	0 - 5	19,200	**960**
1997/04/22	122	3257034	5	Ivy Ave. (24)	Rear	40 - 60	3,680	160 T

Date	No.	Loc. Code	Block	Location No.	Yard res	Depth	Total PAH	B(a)P
1997/07/24	2208	3257079	5	Ivy Ave. (25)	Rear	0 - 5	34,960	**2,600**
1997/07/24	2209	3257080	5	Ivy Ave. (26)	Rear	0 - 5	19,880	**1,600**
1997/04/22	123	3257035	5	Ivy Ave. (27)	Rear	0 - 5	119,240	**5,300**
1997/07/24	2210	3257081	5	Ivy Ave. (28)	Rear	0 - 5	19,060	**1,600**
1997/04/23	124	3257036	6	Ivy Ave. (29)	Front	0 - 5	5,220	**360**
1997/04/23	125	3257037	6	Ivy Ave. (30)	Front	0 - 5	7,640	**480**
1997/04/23	126	3257037	6	Ivy Ave. (30)	Front	40 - 60	560	40 W
1997/04/23	127	3257038	6	Ivy Ave. (31)	Front	0 - 5	8,500	**640**
1997/04/23	128	3257039	7	Ivy Ave. (32)	Front	0 - 5	20,420	**1,500**
1997/04/23	129	3257040	7	Ivy Ave. (33)	Front	0 - 5	19,560	**1,200**
1997/04/23	130	3257040	7	Ivy Ave. (33)	Front	40 - 60	3,180	240
1997/04/23	131	3257041	7	Ivy Ave. (34)	Front	0 - 5	17,480	**1,100**
1997/04/25	168	3257072	8	Ivy Ave. (35)	Front	0 - 5	25,760	**2,000**
1997/07/24	2211	3257082	8	Ivy Ave. (36)	Front	0 - 5	25,560	**1,900**
1997/04/23	132	3257042	8	Ivy Ave. (37)	Front	0 - 5	119,880	**6,600**
1997/04/23	133	3257042	8	Ivy Ave. (37)	Front	40 - 60	2,000	160 T
1997/04/23	134	3257043	8	Ivy Ave. (38)	Front	0 - 5	24,600	**1,700**
1997/04/23	135	3257044	9	Ivy Ave. (39)	Front	0 - 5	12,400	**960**
1997/07/24	2212	3257083	9	Ivy Ave. (40)	Front	0 - 5	7,000	**560**
1997/07/24	2213	3257084	9	Ivy Ave. (41)	Front	0 - 5	6,280	**520**
1997/04/23	136	3257045	9	Ivy Ave. (42)	Front	0 - 5	62,600	**3,800**
1997/04/23	137	3257045	9	Ivy Ave. (42)	Front	40 - 60	580	40 W
1997/07/24	2206	3257077	10	Ivy Ave. (43)	Rear	0 - 5	14,160	**1,000**
1997/04/25	166	3257070	10	Ivy Ave. (44)	Rear	0 - 5	221,580	**13,000**
1997/07/24	2204	3257070	10	Ivy Ave. (44)	Rear	40 - 60	4,480	**360**
1997/07/24	2205	3257076	10	Ivy Ave. (45)	Rear	0 - 5	2,780	240
1997/04/23	138	3257046	10	Ivy Ave. (46)	Rear	0 - 5	6,060	**400**
1997/04/23	139	3257047	10	Ivy Ave. (47)	Front	0 - 5	1,560	120 T
1997/04/23	140	3257048	10	Ivy Ave. (48)	Front	0 - 5	3,900	**320**
1997/04/23	141	3257049	10	Ivy Ave. (49)	Front	0 - 5	7,180	**520**
1997/04/23	142	3257049	10	Ivy Ave. (49)	Front	40 - 60	580	40 W
1997/04/23	143	3257050	11	Ivy Ave. (50)	Rear	0 - 5	5,240	**400**
1997/04/23	144	3257051	11	Ivy Ave. (51)	Front	0 - 5	15,000	**1,100**
1997/04/23	145	3257051	11	Ivy Ave. (51)	Front	40 - 60	1,040	120 T
1997/07/24	2214	3257085	11	Ivy Ave. (52)	Front	0 - 5	32,900	**2,200**
1997/07/24	2215	3257086	11	Ivy Ave. (53)	Front	0 - 5	72,960	**4,500**
1997/07/24	2218	3257089	11	Ivy Ave. (54)	Rear	0 - 5	15,880	**1,?00**
1997/07/24	2216	3257087	11	Ivy Ave. (55)	Front	0 - 5	28,840	**2,?00**
1997/04/23	146	3257052	11	Ivy Ave. (56)	Front	0 - 5	17,960	**1,600**
1997/04/23	147	3257053	11	Ivy Ave. (57)	Front	0 - 5	11,540	**960**

Date	No.	Loc. Code	Block	Location No.	Yard res	Depth	Total PAH	B(a)P
1997/07/24	2217	3257088	11	Ivy Ave. (58)	Front	0 - 5	5,840	**480**
1997/04/24	148	3257054	12	Prust Ave. (59)	Rear	0 - 5	45,140	**3,400**
1997/07/24	2219	3257090	12	Prust Ave. (60)	Side	0 - 5	22,600	**1,700**
1997/04/24	149	3257055	12	Prust Ave. (61)	Front	0 - 5	14,760	**1,100**
1997/07/24	2220	3257091	12	Prust Ave. (62)	Side	0 - 5	15,000	**1,100**
1997/04/24	150	3257056	13	Boultbee Ave. (63)	Rear	0 - 5	14,340	**1,100**
1997/04/24	151	3257056	13	Boultbee Ave. (63)	Rear	40 - 60	1,360	120 T
1997/04/24	152	3257057	13	Boultbee Ave. (64)	Rear	0 - 5	3,440	**320 T**
1997/04/24	153	3257058	13	Boultbee Ave. (65)	Rear	0 - 5	4,460	**400 T**
1997/04/25	154	3257059	14	H & L yard west		0 - 1	1,195,300	**88,000**
1997/04/25	155	3257060	14	H & L yard east		0 - 1	752,600	**55,000**
1997/04/25	156	3257060	14	H & L yard east		60 - 70	1,141,900	**66,000**
1997/04/25	157	3257061	15	Railway right/way 1		0 - 30	146,200	**9,000**
1997/04/25	158	3257062	15	Railway right/way 2		0 - 30	10,180	**720**
1997/04/25	159	3257063	15	Railway right/way 3		0 - 30	580	40 T
1997/04/25	160	3257064	16	Steep Slope 1		0 - 40	12,580	**1,000**
1997/04/25	161	3257065	16	Steep Slope 2		0 - 40	5,700	**480**
1997/04/25	162	3257066	17	Leslieville P.S.		0 - 5	520	40 W
1997/04/25	163	3257067	17	Greenwood Park		0 - 5	2,700	240 T
1997/04/25	164	3257068	18	Dorothy Ave. 1		0 - 5	14,100	**1,100**
1997/04/25	165	3257069	18	Dorothy Ave. 2		0 - 5	5,640	**440**
1997/07/24	2201	3257073	19	Walpole Ave. (66)	Front	0 - 5	7,400	**600**
1997/07/24	2202	3257074	19	Greenwood Ave. (67)	Front	0 - 5	11,720	**880**
1997/07/24	2203	3257075	19	Greenwood Ave. (68)	Front	0 - 5	14,160	**1,100**
1997/08/27	331	3257092	20	Wagstaff Drive 1		0 - 2	178,240	**12,000**
1997/08/27	332	3257093	20	Wagstaff Drive 2		0 - 2	517,940	**36,000**
1997/08/27	333	3257094	20	Wagstaff Drive 3		0 - 2	210,540	**14,000**
1997/08/27	334	3257095	20	Wagstaff Drive 4		0 - 2	64,020	**4,300**
1997/08/27	335	3257096	20	Wagstaff Drive 5		0 - 2	66,580	**4,800**
1997/08/27	336	3257097	20	Wagstaff Drive 6		0 - 2	72,680	**5,300**
1997/08/27	337	3257098	20	Wagstaff Drive 7		0 - 2	914,320	**56,000**
1997/08/27	338	3257099	20	Wagstaff Drive 8		0 - 2	362,640	**32,000**
1997/08/27	339	3257100	20	Wagstaff Drive 9		0 - 2	97,020	**7,300**
1997/08/27	340	3257101	20	Wagstaff Drive 10		0 - 2	49,520	**3,700**

- Bold B(a)P data exceed OTR_{98} guideline for old urban parkland soil (300 ng/g).
- Light shaded B(a)P data exceed remediation criteria for residential/parkland sites (1,200 ng/g).
- Dark shaded B(a)P data exceed remediation criteria for for industrial/commercial sites (1,900 ng/g).

Discussion:

The allegation under investigation is that the PAH contamination of soil in this neighbourhood is due to spills of coal tar based materials in the storage yard and along the Wagstaff Drive roadbed. Coal tar pitch was used extensively as a roofing material up to the mid 1970s. Heather and Little Limited would have handled large quantities of coal tar pitch. Spills to the yard and roadbed surfaces would result in PAH contaminated soil and dust particles which could then be physically tracked, blown by wind, or carried by precipitation runoff to other areas. This discussion will look for evidence to support this allegation.

Initially, however, it is important to point out that PAHs are ubiquitous contaminants of soil, especially in urban areas. PAHs are created when there is incomplete combustion of organic materials. Common sources include vehicle emissions, especially from diesel engines, coal or wood burning furnaces, and certain industrial processes. The Phytotoxicology Section's Ontario Typical Range (OTR) guideline for B(a)P in soil from old urban parkland sites is 300 ng/g. This guideline is based on extensive sampling of soil in urban parks located in older, established areas in various municipalities throughout Ontario. This value, referred to as OTR_{98}, represents the high end of the concentration range for B(a)P in soil from such locations. Appendix 2 contains a discussion of OTR soil guidelines.

Before examining the PAH data for samples collected from the surrounding neighbourhood, it would be worthwhile to assess the conditions in the H&L yard and the Wagstaff Drive roadbed. Significant PAH contamination would have to be present at these locations as the first step toward proving the allegation. The yard and roadbed are designated as Blocks 14 and 20, respectively, in the results table.

The PAH concentrations in the two surface samples from the H&L yard were extremely high. Interestingly, the sample collected at depth has similar concentrations to those from the surface. This suggests burial of PAH contaminated material, possibly during the construction of the retaining wall and levelling of the yard. Because the concentrations are so high, the H&L yard is unquestionably a source of PAHs in the neighbourhood.

The soil collected from beneath the pavement on Wagstaff Drive also had high PAH concentrations. These concentrations covered a very wide range. For example, B(a)P ranged from 4,300 to 56,000 ng/g. At the high end, these concentrations approached those of the H&L yard. During sampling it was observed that the soil beneath the pavement was very dark.

Sampling in the H&L yard and from beneath the pavement on Wagstaff Drive revealed significant PAH contamination of these areas. The high concentrations in the yard were anticipated given that coal tar products would have been stored here. The wide range of concentrations along Wagstaff Drive, including some that approached the yard concentrations, supports the allegation that coal tar products were intermittently spilled to the dirt roadbed while in transit to and from H&L. Therefore, the roadbed is also a source of PAH contamination in the neighbourhood.

Having established the H&L yard and the Wagstaff Drive roadbed, prior to paving, as sources of the PAHs, it is now appropriate to examine contamination patterns at other locations and ascertain how they can be related to these sources.

Block 1 consists of rear yards of properties from 14 to 36 Ivy Avenue. These yards are characterised by terraces. These were necessary because of the rapid increase in elevation from

the south to the north end of the yards. PAH concentrations encountered here were typical of urban soil. The unusually low surface soil concentration at Location No. 3 suggests some disturbance, possible during terrace construction or maintenance.

Block 2 locations included rear yards from 38 to 48 Ivy Avenue. These yards were very shallow but still characterised by similar increases in elevation. Only two locations were sampled, yielding very different results. Location No. 4 had typical urban background concentrations of PAHs. Location No. 5, which was closer to the H&L yard, had elevated PAHs.

Block 3 locations included all the rear yards that abutted the retaining wall that held back the fill used to construct the H&L yard and an adjoining parking area. Several yards in this Block were sampled in 1995. All surface samples from this Block exceed the OTR_{98} guideline and many exceed the remmediation criteria. There is a considerable range to the surface soil PAH concentrations in this Block. Interestingly, the lowest concentrations coincide with those yards that are known or suspected of having had new soil added, namely Location No. 6 and 7. Also, two of the yards with higher concentrations, Location No. 13 and 14, abutted the retaining wall where vehicles were parked, not where roofing supplies were stored.

Blocks 4 and 5 include all rear yards from 88 to 134 Ivy Avenue. These yards abut Wagstaff Drive. PAH concentrations in the surface soil are similar to those in Block 3. With the exception of Location No. 23, the surface soil in all sampled yards exceed the B(a)P remmediation criterion. It appears that the contaminated roadbed influenced the adjoining residential properties in a manner similar to that of the contaminated storage yard.

Data from these Blocks also demonstrate that PAH concentrations are much lower in the 40 to 60 centimetre depth. This pattern is evident at virtually all locations where both types of samples were collected. This points to deposition of PAHs to the soil surface, as opposed to contaminated soil used as fill.

Blocks 6, 7, 8 and 9 include the front yards of almost all the properties on the north side of Ivy Avenue, from number 26 to the east end. With one notable exception (Location 42), the data suggest a pattern of higher PAH contamination within Blocks 7 and 8. These front yard locations are at properties where rear yards were also highly contaminated. At this time there is no explanation for the very high PAHs at Location 42 in Block 9. Other front yards in this Block have much lower PAH concentrations.

Block 10 locations included front and rear yards of properties on the south side of Ivy Avenue, west of Prust Avenue. As a rule, surface soil PAH concentrations are near the OTR_{98} guideline value. A notable exception is Location 44, with a B(a)P concentration of 13,000 ng/g. The sample collected immediately next door at Location 45 has a much lower concentration, in line with others in this Block. The highly elevated PAHs at Location 44 appear to be an anomaly.

Block 11 locations included front and rear yards of properties on the south side of Ivy Avenue, east of Prust Avenue. All surface samples are above the OTR_{98} guideline, and most exceed the remmediation criterion. This is the first evidence that the PAH contamination is not confined to properties on the north side of Ivy Avenue.

Block 12 contained front, side and rear yards of the properties at the north end of Prust Avenue. All four samples exceeded the OTR_{98} guideline for B(a)P while two exceeded the remmediation criterion. These observations support those from Block 11, namely that the contamination crosses Ivy Avenue.

To ascertain whether PAHs were present in residential properties to the north of the H&L yard, several rear yards at the east end of Boultbee Avenue were identified as Block 13. Three of these were sampled. Two had surface soil B(a)P near the OTR_{98} guideline. The third, at 1,100 ng/g, was just below the remmediation criterion.

Blocks 15 and 16 were established to ascertain if there was any evidence for PAH contamination of non-residential locations to the north. Three locations within the railway right-of-way were sampled. Railway lands frequently contain PAHs as a result of the treatment applied to railway ties. Also sampled were two locations within the steep embankment north or the Thomson Groceries shipping area, and north of the H&L yard.

The three railway right-of-way samples show a wide concentration range. As these 0 to 30 centimetre samples were collected, it was noted that the soil from the first two locations was very dark, with the top 20 centimetres described as "black sand over clean sand". At the third location, the sand had the normal buff colour. Coincidently, the first two samples had elevated PAHs, while the third was below urban background.

It is unlikely that the contamination found along the railway right-of-way was associated with the H&L yard since the most contaminated of the three locations was the most distant from the yard. It appears that contaminant responsible for the discolouration of the sand also contained PAHs. Creosote, used as a wood preservative on railway ties, is a likely candidate.

The samples from the embankment (Block 16) have some PAH contamination, with B(a)P between the OTR_{98} guideline and the remmediation criterion. Unfortunately, the steep nature of the terrain required some compromise in the sampling protocol. It appeared that slumping and erosion were active and therefore it was difficult to determine what was actually surface soil. As a compromise, the top 40 centimetres were sampled. Because of the erosion and slumping of the face of the slope, it is impractical to interpret the data.

Block 17 consisted of two locations well removed from the Ivy Avenue area. One was from the playing field of Leslieville Public School and the other was from a location in Greenwood Park. The park location had normal urban background concentrations, while the school location was considerably lower. Landscaping activities at the school may have introduced some clean soil to the playing field.

Two locations along Dorothy Street (Block 18) were sampled at the request of the Environmental Officer with the MOE Toronto District Office. Dorothy Street was apparently also an unpaved municipal roadway, similar to Wagstaff Drive. The question that was to be addressed was whether there was any unusual PAH contamination on properties along Dorothy Street. Roadways that were unpaved could be quite dusty. Oiling of these roadways to suppress dust was a common practice. The most likely type of oil used for such purposes would be used crankcase oil, which is normally enriched in PAHs.

If exceptional PAH contamination was present along Dorothy Street, then there could be an argument made for dust suppression treatments of Wagstaff Drive as a source of some of the PAH contamination. Both sample locations along Dorothy Street have somewhat elevated concentrations (above the OTR_{98} guideline but below the remmediation criterion), although not in the same league as those in the Ivy Avenue area. The reason for these elevated concentrations may be due to the fact that Dorothy Street is part of the route for the Toronto Transit Commission's Greenwood Avenue bus. There is a bus stop at the location where the higher of

the two PAH concentrations were found. Diesel engine exhaust is a known source of PAH-enriched particulates.

Block 19 consisted of some front yards on the east of Greenwood Avenue. The B(a)P concentrations fall above the OTR_{98} guideline but below the remmediation criterion. These moderate elevations may be tentatively attributed to dust from the unpaved Wagstaff Drive roadbed, which extents all the way to Greenwood Avenue, directly west of the sampled locations.

Summary and Conclusions:

This investigation included extensive sampling of residential properties in the Ivy Avenue neighbourhood in an attempt to delineate the extent of unusually high soil PAH concentrations. It also included sampling from non-residential properties in an attempt to identify the probable source of this contamination.

Extremely high concentrations of PAHs were discovered in the soil at the H&L storage yard, as well as beneath the concrete pavement on Wagstaff Drive. This identified these locations as potential sources of the PAH contamination found throughout the neighbourhood.

As a rule, surface soil samples collected from most residential yard locations contained PAH concentrations, exemplified by B(a)P, that exceeded the OTR_{98} guideline. Many of these also exceeded the MOE remmediation criterion for B(a)P. Given that no other PAH source has been identified, and since there is evidence for higher PAH concentrations at locations that are in close proximity to the H&L yard or Wagstaff Drive, it can be concluded that these two areas are responsible for elevated PAH concentrations throughout the neighbourhood.

Since many of the contaminated locations are not directly adjacent to either source, the mechanism by which the PAHs spread must have been re-entrainment, that is wind raising fine soil or dust particles from these contaminated surfaces and depositing them on remote properties.

One observation that remains unreconciled is the occasional occurrence of some very high PAH concentrations on certain residential properties. Examples of these are Location Nos. 9, 13, 14 and 18. B(a)P concentrations at these locations are much higher that at other, immediately adjacent properties, and exceed what is being presumed to be due to re-entrainment by wind from contaminated locations. A reasonable explanation for these observations may be related to the physiographic features of this neighbourhood.

This neighbourhood is situated on some hilly terrain. As was mentioned earlier, a retaining wall was constructed to create the now level H&L yard. This left several rear yards in Block 3 some two or three metres lower. Also, many of the properties abutting Wagstaff Drive are at a lower elevation than the roadbed. It is suggested that rain storm and snow melt runoff from the heavily contaminated yard and roadbed carried the fine, PAH-laden soil and dust particles to the adjacent lower properties.

APPENDIX 1

Derivation and Significance of the MOEE Soil Remmediation Criteria (Clean-up Guidelines)

The MOEE Soil Remmediation Criteria have been developed to provide guidance in cleaning up contaminated soil. They are not action levels, in that an exceedence of one or more of the criteria does not automatically mean that a clean-up must be conducted. A site clean-up may be conducted when a contaminated property is sold and/or the land use is changed. For example, the owner of an industrial property who plans to sell his/her land to a developer who intends to build residential homes can use the Remmediation Criteria to clean up the soil to meet the residential land use criteria. This will allow the site to be reused for residential land-use without concern for adverse effects.

When contamination is found at a site where a change in land-use is not planned, the criteria may be used to assist in making decisions about adverse effects and the need for remmediation. This is different from the previously described situation where a decision to change the land-use has already been made and the level of remmediation required to rule out the potential for adverse effects is established by the new land use. Decisions on the need to undertake remedial action when the criteria are exceeded, and where the land use is not changing, require consideration of factors such as:

- the demonstrated presence or likelihood of an adverse effect (on and off property);
- an understanding of the type of protection provided by the criteria gained through knowledge of the exposure pathways and receptors which were considered in the development of the criteria, and through understanding how that combination of pathways and receptors relate to those which could be found at the site;
- an understanding of the relationship between dose and health response for sensitive receptors from all exposure pathways, including the safety and uncertainty factors that have been used in the development of the criteria;
- an understanding of the environmental characteristics of the contaminants and of the site conditions that could influence the migration of the contaminants and how this effects their exposure and response characteristics.

In each case, the decision to undertake or not undertake site remmediation should entail all of these factors plus any additional factors specific to the site in question. When the decision is made that remedial action is needed, the criteria can be used as clean-up targets. If these criteria are unacceptable to the proponent undertaking the remmediation, they have an option to develop local back-ground-based criteria or conduct a site specific risk assessment.

The Soil Remmediation Criteria are effects-based concentrations set to protect against the potential for adverse effects to human health, ecological health, and the natural environment, whichever is the most sensitive. By protecting the most sensitive parameter the rest of the environment is protected by default. There are different Soil Remmediation Criteria for soil texture, soil depth, and ground water use. The criteria have also been established so that there will not be a potential for adverse effects through contaminant transfer from soil to indoor air, from ground water or surface water through release of volatile gases, from leaching of contaminants in soil to ground water, or from ground water discharge to surface water. However, use of these criteria may not ensure that corrosive, explosive, or unstable soil conditions will be eliminated.

The Soil Remmediation Criteria were developed from published U.S. EPA and Ontario environmental data bases. Currently there are criteria for about 25 inorganic elements and about 90 organic compounds. Criteria were developed only if there were sufficient, defendable, effects-based data on the potential to cause an adverse effect. All of the criteria address human health and aquatic toxicity, but terrestrial ecological toxicity information was not available for all elements or compounds. The development of Soil Remmediation Criteria is a continuous program, and criteria for more elements and compounds will be developed as additional environmenta dat become available. Similarly, new information could result in future modifications to the existing criteria.

For more information on the Remmediation Criteria please refer to the *Guideline for Use at Contaminated Sites in Ontario. Revised December 1996*, Ontario Ministry of Environment and Energy, PIBs 3161E01, ISBN 0-7778-5905-X.

APPENDIX 2

Derivation and Significance of the MOEE "Ontario Typical Range" Soil Guidelines

The MOEE "Ontario Typical Range" (OTR) guidelines are being developed to assist in interpreting analytical data and evaluating source-related impacts on the terrestrial environment. The OTRs are used to determine if the level of a chemical parameter in soil, plants, moss bags, or snow is significantly greater than the normal background range. An exceedence of the OTR_{98} (*the OTR_{98} is the actual guideline number*) may indicate the presence of a potential point source of contamination.

The OTR_{98} represents the expected range of concentrations of chemical parameters in surface soil, plants, moss bags, and snow from areas in Ontario not subjected to the influence of known point sources of pollution. The OTR_{98} represents 97.5 percent of the data in the OTR distribution. This is equivalent to the mean plus two standard deviations, which is similar to the previous MOEE "Upper Limit of Normal" (ULN) guidelines. In other words, 98 out of every 100 background samples should be lower than the OTR_{98}.

The OTR_{98} may vary between land use categories even in the absence of a point source of pollution because of natural variation and the amount and type of human activity, both past and present. Therefore, OTRs are being developed for several land use categories. The three main land use categories are Rural, New Urban, and Old Urban. Urban is defined as an area that has municipal water and sewage services. Old Urban is any area that has been developed as an urban area for more than 40 years. Rural is all other areas. These major land use categories are further broken into three subcategories; Parkland (which includes greenbelts and woodlands), Residential, and Industrial (which includes heavy industry, commercial properties such as malls, and transportation rights-of-way). Rural also includes an Agricultural category.

The OTR guidelines apply only to samples collected using standard MOEE sampling, sample preparation, and analytical protocols. Because the background data were collected in Ontario, the OTRs represent Ontario environmental conditions.

The OTRs are not the only means by which results are interpreted. Data interpretation should involve reviewing results from control samples, examining all the survey data for evidence of a pattern of contamination relative to the suspected source, and where available, comparison with effects-based guidelines. The OTRs are particularly useful where there is uncertainty regarding local background concentrations and/or insufficient samples were collected to determine a contamination gradient. OTRs are also used to determine where in the anticipated range a result falls. This can identify a potential concern even when a result falls within the guideline. For example, if all of the results from a survey are close to the OTR_{98} this could indicate that the local environment has been contaminated above the *anticipated average,* and therefore the pollution source should be more closely monitored.

The OTRs identify a range of chemical parameters resulting from natural variation and normal human activity. ***As a result, it must be stressed that values falling within a specific OTR_{98} should not be considered as acceptable or desirable levels; nor does the OTR_{98} imply toxicity to plants, animals or humans.*** Rather, the OTR_{98} is a level which, if exceeded, prompts further investigation on a case by case basis to determine the significance, if any, of the above normal concentration. Incidental, isolated or spurious exceedences of an OTR_{98} do not necessarily indicate a need for regulatory or abatement activity. However, repeated and/or extensive exceedences of an OTR_{98} that appears to be related to a potential pollution source does indicate the need for a thorough evaluation of the regulatory or abatement program.

The OTR_{98} supersedes the Phytotoxicology ULN guideline. The OTR program is on-going. The number of OTRs will be continuously updated as sampling is completed for the various land use categories and sample types. For more information on these guidelines please refer to *Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags, and Snow. MOEE Report No.: HCB-151-3512-93, PIBs No.: 2792, ISBN 0-778-1979-1.*